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Maentele et al.

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(54) **WASHING MACHINE WITH A DIRECT DRIVE SYSTEM**

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(51) **Int. Cl.**

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D06F 37/26	(2006.01)
D06F 37/30	(2006.01)

(52) **U.S. Cl.**

CPC ***A47L 15/4246*** (2013.01); ***D06F 37/206*** (2013.01); ***D06F 37/26*** (2013.01); ***D06F 37/304*** (2013.01); *Y10T 29/49009* (2015.01); *Y10T 29/49826* (2015.01)

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CPC D06F 37/30; D06F 37/304; D06F 37/306; D06F 37/308; D06F 37/32; D06F 37/34; D06F 37/36; D06F 37/38; D06F 37/40

See application file for complete search history.

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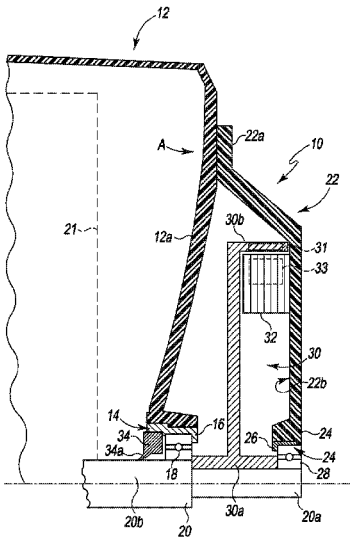
Primary Examiner — David Cormier

(57) **ABSTRACT**

A washing machine with a direct drive system including a tub, a drum rotatably mounted inside the tub, a shaft connected to the drum at a first end for transmission of a driving force of a direct drive motor, a coaxial support connected to a rear portion of the tub and having a first seat for a first bearing supporting a second end of the shaft opposite the drum, a stator secured to the coaxial support and having a plurality of magnetic cores, a rotor including permanent magnets and connected to the shaft, and a second bearing for supporting the shaft between the second end and the first end. The tub is made of polymeric material in which a second seat for said second bearing is co-molded.

16 Claims, 4 Drawing Sheets



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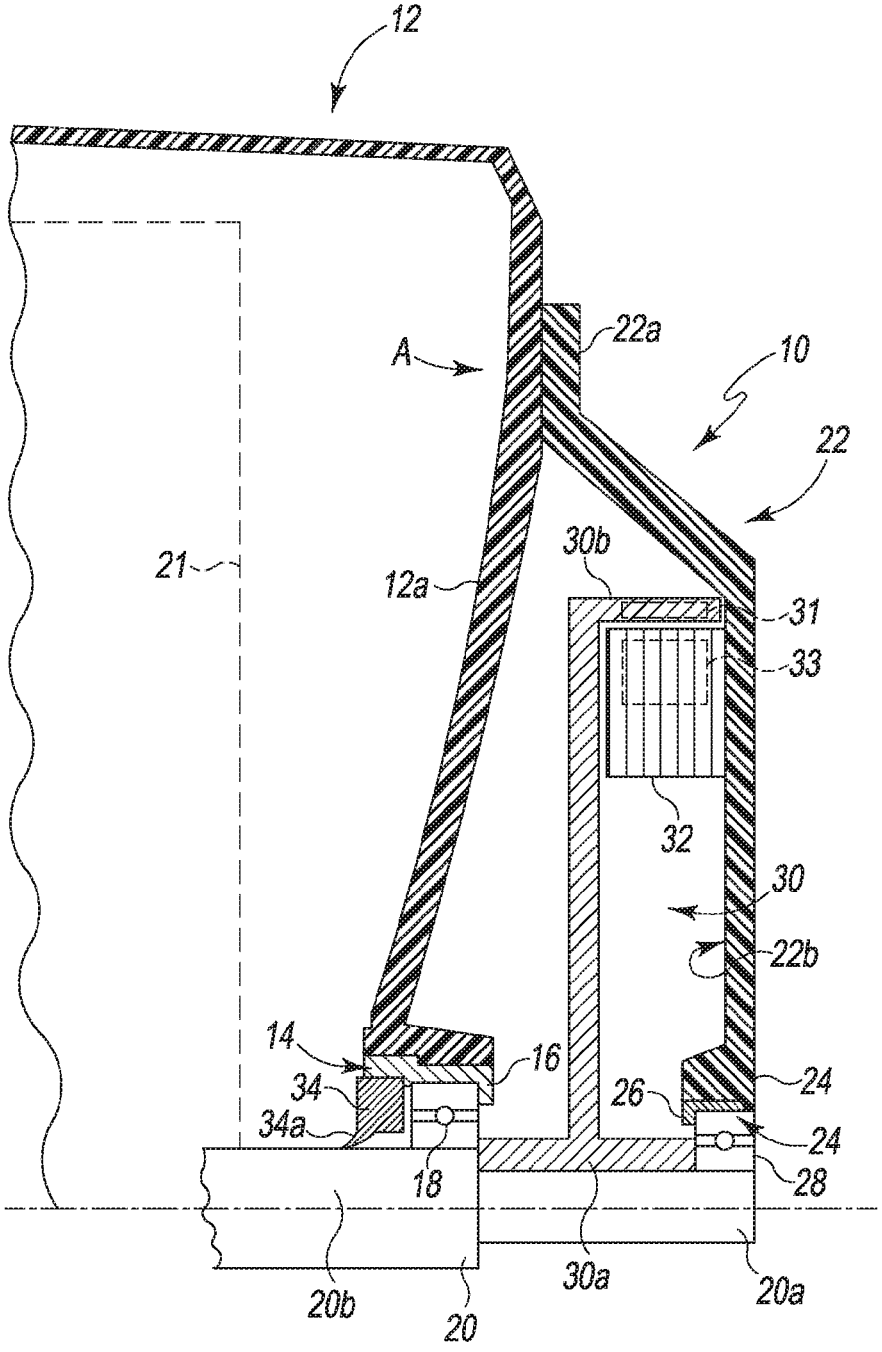
12
A
22a
10
22
21
12a
30b
31
33
32
30
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14
16
34
34a
18
26
24
24
28
20b
20
30a
20a

Fig. 1

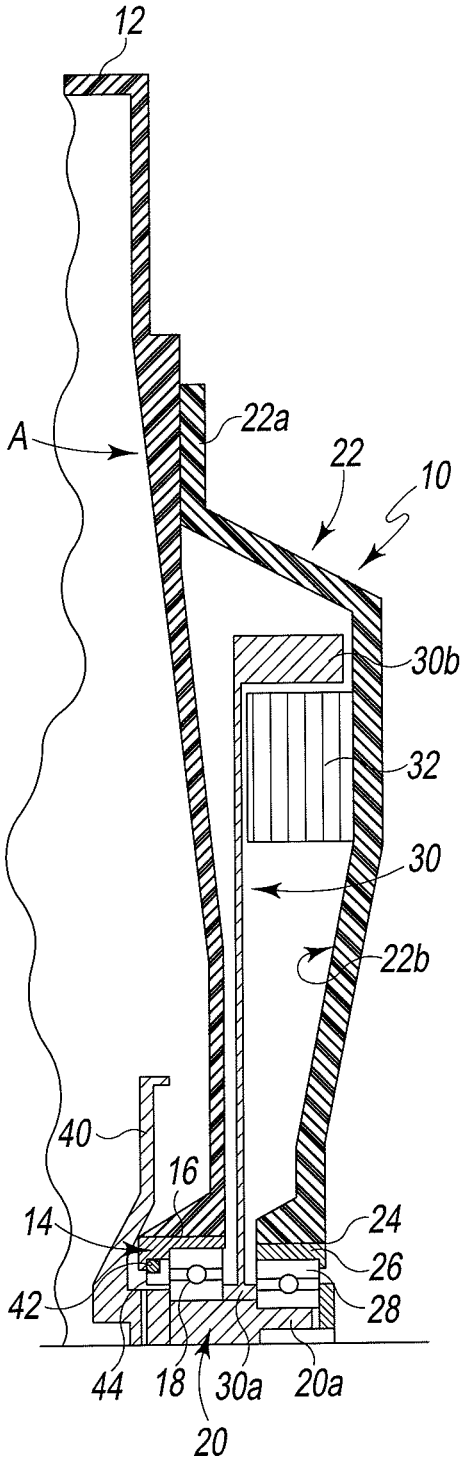
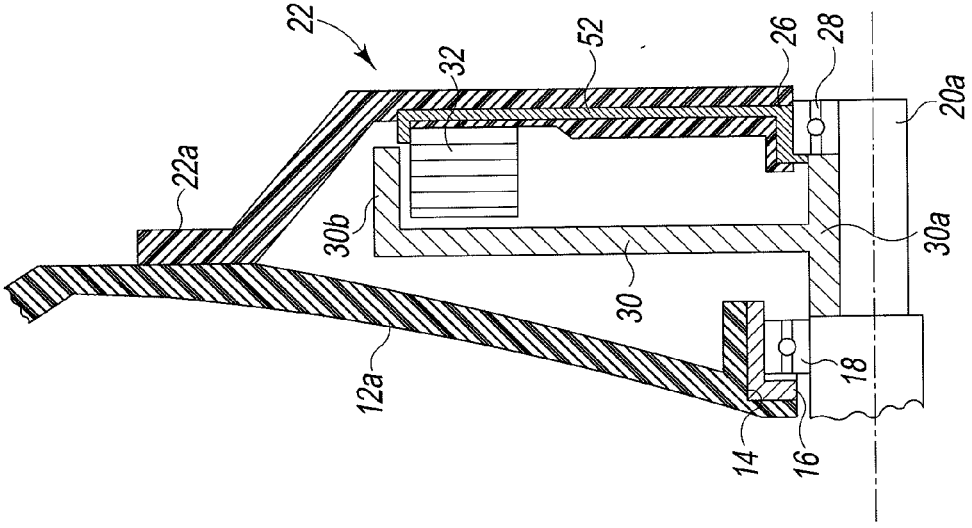


Fig. 2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32
52
26
28
20a
22a
30b
30a
30
12a
18
14
16

Fig. 4

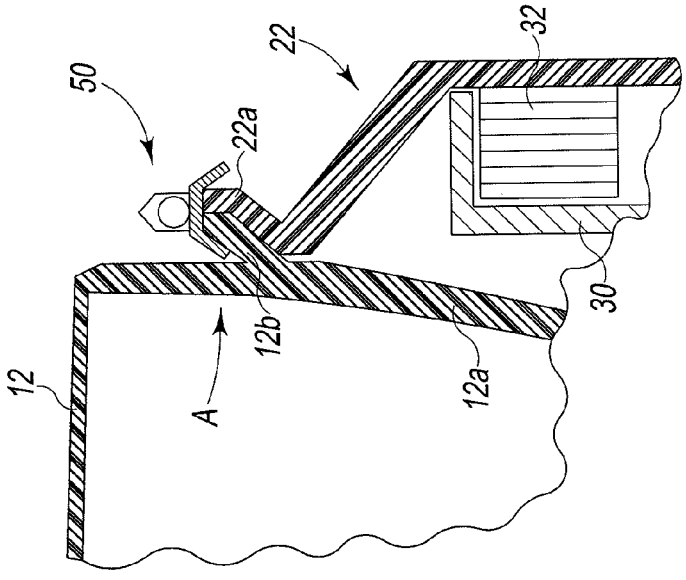
50
22
32
22a
30
12b
12a
12
A

Fig. 3

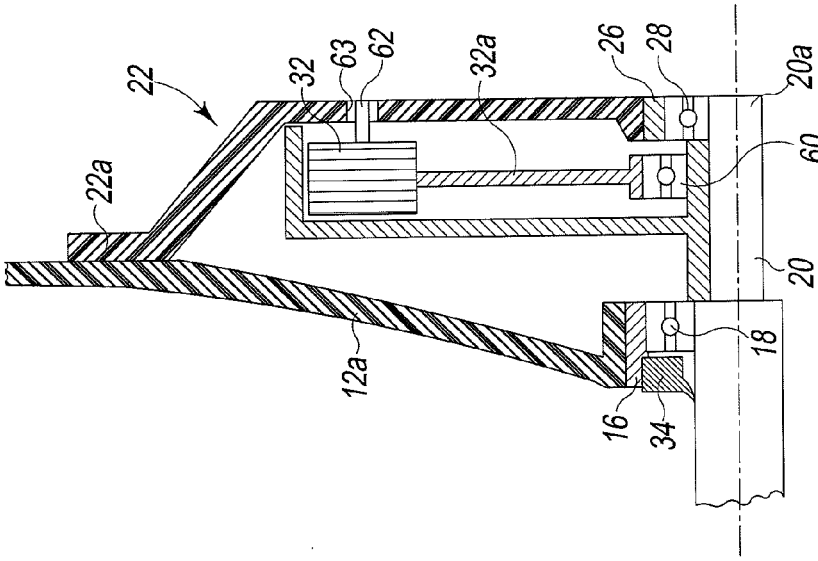
22
32
63
62
32a
26
28
20a
22a
60
20
12a
18
16
34

Fig. 6

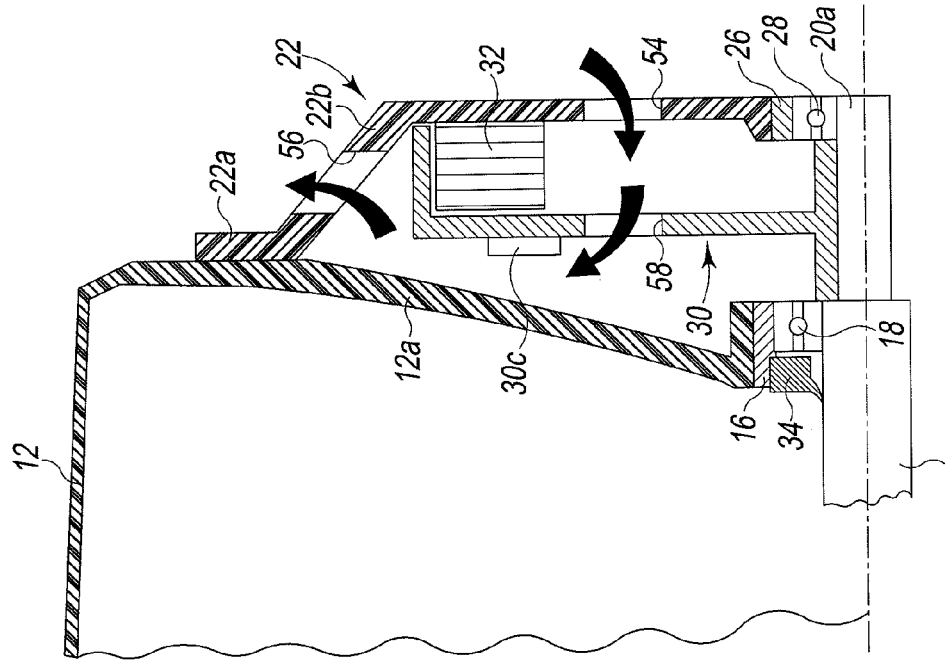
22
22b
56
32
54
26
28
20a
22a
58
30
12a
30c
18
16
34
12
20

Fig. 5

WASHING MACHINE WITH A DIRECT DRIVE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a divisional application of U.S. patent application Ser. No. 12/814,539 entitled "WASHING MACHINE WITH A DIRECT DRIVE SYSTEM" filed Jun. 14, 2010, now U.S. Pat. No. 8,616,029, issued on Dec. 31, 2013, which is incorporated herein by reference.

Cross-reference is made to European Patent Application No. 08103960.4 entitled "Washing machine with a direct drive system," which was filed on May 14, 2008 and is expressly incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to a washing machine and more particularly to a drive system for a washing machine.

BACKGROUND

The present disclosure relates to a washing machine with a so called direct drive system. More particularly, the present disclosure relates to a washing machine comprising a tub, a drum rotatably mounted inside the tub, a shaft centrally connected to the drum for transmitting the drive force of a motor, a coaxial support connected to the rear portion of the tub and having a seat for a first bearing supporting an end of the shaft opposite the drum, a stator of the motor supported by the coaxial support and having a plurality of magnetic cores, a rotor of the motor provided with permanent magnets and connected to the shaft, and a second bearing for supporting a portion of the shaft between its end and the drum.

This kind of washing machine is disclosed by FR-A-1354594. In this known machine the coaxial support is cup-shaped and is provided, on its concave side, with a cup-shaped auxiliary support to which the annular seat of the second bearing is fixed. The two cup-shaped supports define together a round chamber where the rotor and the stator are mounted. In this known construction, where the tub and the two above supports are made of metal, the annular seat of the second bearing is a metal hub with an external annular flange interposed between the rear portion of the metal tub and a central portion of the cup-shaped auxiliary support.

In view of the above features, the installation of the direct drive motor system to the washing machine is quite complex since at least two pieces have to be fastened to the tub, i.e. the cup-shaped "external" support and the cup-shaped "internal" auxiliary support. This complexity has prevented any appliance producer from adopting this technical solution.

Another similar solution is disclosed by U.S. Pat. No. 5,809,809 where the motor, with its stator and rotor, can be detached as a single component from the shaft, since the rotor present a central hub supported by the disk-shaped housing by means of two roller bearings. Even if this solution presents the advantage of keeping the components of the direct drive motor all together, on the other hand it is quite complex from a mechanical point of view and presents a higher number of components if compared to the traditional direct drive systems. Moreover in this solution all the mechanical loads of the drum are supported by an outside component (the disc-shaped motor) fixed on a rear face of the tub. This concentration of forces in the fastening area of the motor can create problems of reliability and safety.

Further features and advantages of the present invention will be clear from the detailed description of specific embodiments.

SUMMARY

According to one aspect of the disclosure, a washing machine with a direct drive system is disclosed. The washing machine includes a tub, a drum rotatably mounted inside the tub, a shaft connected to the drum at a first end for transmission of a driving force of a direct drive motor, a coaxial support connected to a rear portion of the tub and having a first seat for a first bearing supporting a second end of the shaft opposite the drum, a stator secured to the coaxial support and having a plurality of magnetic cores, a rotor including permanent magnets and connected to the shaft, and a second bearing for supporting the shaft between the second end and the first end. The tub is made of polymeric material in which a second seat for said second bearing is co-molded. In some embodiments, the coaxial support may be made of polymeric material, and the first seat for the first bearing may be co-molded with said coaxial support.

In some embodiments, the coaxial support and the tub may be made of a substantially identical polymeric material and are joined together by welding. Additionally, in some embodiments, the coaxial support and the tub may be joined together by friction welding. In some embodiments, the coaxial support and the tub may be fastened together by means of a fixing ring device.

In some embodiments, the stator may be centrally supported by an auxiliary bearing mounted on the rotor. In some embodiments, the stator may be prevented from rotating on the rotor by restraining means cooperating with corresponding portions of the coaxial support. In some embodiments, the coaxial support may be disc-shaped and the stator may be fixed to an inner surface of the coaxial support.

Additionally, in some embodiments, the rotor may be cup-shaped and may have an L-shaped flange including said permanent magnets. In some embodiments, the first seat of the first bearing may be fixed to or integral with a metal element extending from the seat to the stator. In some embodiments, the metal element may be disc-shaped and may be co-molded with the coaxial support.

In some embodiments, each of the coaxial support and the rotor may include a number of apertures that permit the flow of cooling air. In some embodiments, the coaxial support may include a first series of inner apertures and a second series of outer apertures. Additionally, in some embodiments, the rotor may include shaped ribs acting as blades for driving a cooling air flow.

According to another aspect, a method for installing a direct drive motor on a washing machine is disclosed. The method includes positioning a drum within a polymeric tub of a dishwashing machine, and inserting a shaft secured to the drum at a first end into a first bearing. The first bearing is positioned in a first seat co-molded in the tub. The method includes mounting a rotor including permanent magnets on the shaft after inserting the shaft into the first bearing, and placing a second bearing in a second seat of a coaxial support. The coaxial support has a stator secured thereto. The method also includes positioning the second bearing and the coaxial support on a second end of the shaft positioned opposite the first end, and securing the coaxial support to the tub.

In some embodiments, securing the coaxial support to the tub may include welding the coaxial support to the tub. In some embodiments, welding the coaxial support to the tub may include friction welding the coaxial support to the tub. Additionally, in some embodiments, securing the coaxial support to the tub may include fastening the tub to the coaxial support using a fixing ring device.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description particularly refers to the following figures, in which:

FIG. **1** is a fragmentary half-sectional view of a tub and of the direct drive system of a front loading washing machine;

FIG. **2** is a view similar to FIG. **1** and relates to a top-loading washing machine;

FIG. **3** is a fragmentary sectional view of a detail of FIG. **1** according to a second embodiment;

FIG. **4** is a view similar to FIG. **1** and it shows a third embodiment;

FIG. **5** is a view similar to FIG. **1** and it shows a fourth embodiment; and

FIG. **6** is a view similar to FIG. **1** and it shows a fifth embodiment.

DETAILED DESCRIPTION OF THE DRAWINGS

While the concepts of the present disclosure are susceptible to various modifications and alternative forms, specific exemplary embodiments thereof have been shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that there is no intent to limit the concepts of the present disclosure to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

With reference to FIG. **1**, with **10** it is indicated the direct drive motor of a washing machine whose plastic tub is indicated with reference **12**. The plastic tub **12** presents a rear circular wall **12***a* with a central hole **14** in which a metal hub **16** is installed. The metal hub **16**, which is fixed to the tub **12** by a co-molding process, is the seat of a roller bearing **18** in which a shaft **20** of the drum **21** is rotatably mounted.

On a peripheral portion A of the rear wall **12***a* of the tub **12**, the flange **22***a* of a disc-shaped plastic support part **22** is fixed by means of friction welding. In order to improve the quality of the friction welding, the polymeric material of the tub **12** and the polymeric material of the disc-shaped support part **22** are preferably identical. In a central hole **24** of the support part **22** a metal hub **26** is fixed by co-molding. The metal hub **26** is used as a seat of a roller bearing **28** which rotatably supports a free end **20***a* of the shaft **20**.

Between the roller bearings **18** and **28**, on the shaft **20** it is keyed a central hub **30***a* of a rotor **30** which presents an L-shaped flange **30***b* provided with a plurality of permanent magnets **31**. The rotor **30** of the direct drive motor **10** cooperates with a stator **32** connected to an inner face **22***b* of the disc-shaped support part **22**. The stator **32**, as it is well known in the art of direct drive systems, is provided with a plurality of magnetic cores **33** driven by a control and power unit of the washing machine.

On the inner part of the hub **16**, an annular gasket **34** is mounted for preventing the liquid in the tub **12** from flowing out. The gasket **34** has an inner lip **34***a* cooperating with a polished surface **20***b* of the shaft **20**.

For mounting the motor **10** on the washing machine, the first step is to install the shaft **20** (carrying the drum) in the roller bearing **18**. The second step is to install the rotor **30** on the shaft **20** so that the rotor is rotationally fixed to the shaft. Then the last step is to center the support part **22** with the stator **32** on the end **20***a* of the shaft **20**, by also frictionally welding the support part **22** to the tub **12**.

In FIG. **2** the solution for a top-loader is almost identical to the solution for a front loader, and the main difference is the reduced space taken by the direct drive motor and the related bearings assembly. In FIG. **2** the same components are indicated with the same reference numerals of FIG. **1**. In the version of the top loader, the shaft **20** ends inside the tub **12** with an annular flange **40** fixed to a circular side (not shown) of the drum. In this version a circular gasket **42**, in the form of an O-ring, cooperates with a L-shaped ring **44** fixed on the shaft **20**.

In FIG. **3** another embodiment is shown in which the disc-shaped plastic support **22** is fastened to the tub **12** by means of a fastening ring **50** formed by a metal V-band. Such ring **50** is clamped in a known manner on a peripheral protruding portion **12***b* of the tub **12** and on the flange **22***a* of the support part **22**.

With reference to FIG. **4**, a third embodiment is shown in which a metal disc-shaped sheet or plate **52** is fixed to or integral with the metal hub **26** used as a seat for the roller bearing **28**. The metal sheet **52** can be co-molded with the plastic support part **22** (solution shown in the drawings) or it can be fixed to an inner or outer face thereof. The metal sheet **52** extends the metal hub **26** to the outside diameter of the stator **32**, therefore increasing the stiffness of the overall direct drive motor assembly and allowing the stator **32** to be mounted on a metal component for reducing the mounting tolerances of the stator **32**.

In the fourth embodiment shown in FIG. **5** the support part **22** is provided with a first series of apertures or holes **54** and with a second series of apertures or holes **56**. The holes **54** are placed in a central flat portion of the support part **22** and the holes **56** are placed in an outer inclined portion **22***b* of the support part **22**. The rotor **30** is further provided with a plurality of apertures or holes **58** in order to allow a free airflow inside the inner space defined by the support part **22** and by the rear wall **12***a* of the tub **12**. In order to create a stronger continuous flow of cooling air (flow schematically shown in FIG. **5** by arrows), the rotor **30** is provided with a plurality of shaped ribs **30***c* adjacent the L-shaped flange **30***b*. The ribs **30***c* act as blades of a cooling fan, therefore reducing the working temperature of the motor.

In the fifth embodiment shown in FIG. **6** the stator **32** is not fastened to the support part **22** as in the previous embodiments, rather it is centered to the rotor **30** by means of an additional bearing **60** and it is restrained by a pin **62** to the support part **22**. The stator **32** is therefore provided with a disc-shaped support **32***a* mounted on the outer ring of the additional bearing **60**, the inner ring of such bearing **60** being mounted on the central hub **30***a* of the rotor **30**. In this embodiment the stator **32** is prevented from turning by means of the pin **62** (or by means of a plurality of pins) inserted in a corresponding seat **63** of the support part **22**, with a flexible mount against the support part **22**.

Even if in the above embodiments the rotor **30** is shown as a cup-shaped rotor, it is clear that the rotor may have other configurations, for instance purely disc-shaped configurations or configurations with a double L-shaped flange (i.e. T-shaped flange) carrying magnets on the two portions of the flange, without departing from the scope of the present invention. Similarly, the stator **32** too can have different

configurations, and the poles thereof can also be U-shaped when a purely disc-shaped configuration of the rotor **30** is adopted.

There are a plurality of advantages of the present disclosure arising from the various features of the method, apparatus, and system described herein. It will be noted that alternative embodiments of the method, apparatus, and system of the present disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of the method, apparatus, and system that incorporate one or more of the features of the present invention and fall within the spirit and scope of the present disclosure as defined by the appended claims.

The invention claimed is:

1. A method for installing a direct drive motor on a washing machine, comprising:

positioning a drum within a polymeric tub of a washing machine,

inserting a shaft secured to the drum at a first end into a first bearing, the first bearing being positioned in a first seat co-molded in the tub,

mounting, after inserting the shaft into the first bearing, a rotor on the shaft by sliding a base of the rotor onto the shaft and into contact with the first bearing, the rotor including permanent magnets,

placing a second bearing in a second seat of a coaxial support, the coaxial support having a stator secured thereto,

positioning the second bearing and the coaxial support on a second end of the shaft positioned opposite the first end by sliding the second bearing into contact with the base of the rotor, and

securing the coaxial support to the tub.

2. The method of claim **1**, wherein securing the coaxial support to the tub includes welding the coaxial support to the tub.

3. The method of claim **2**, wherein welding the coaxial support to the tub includes friction welding the coaxial support to the tub.

4. The method of claim **1**, wherein securing the coaxial support to the tub includes fastening the tub to the coaxial support using a fixing ring device.

5. The method of claim **1**, wherein mounting the rotor further includes positioning an arm of the rotor that extends outwardly away from the base between the stator and the polymeric tub.

6. The method of claim **5**, wherein positioning the arm further includes positioning the permanent magnets of the rotor to be radially outward from the stator.

7. The method of claim **5**, wherein positioning the arm further includes positioning a flange of the arm to be radially outward from the stator, relative to the shaft.

8. The method of claim **1**, further comprising inserting a gasket having an inner lip between the shaft and the first seat, the gasket to prevent liquid in the tub from flowing out.

9. The method of claim **8**, wherein inserting the gasket further includes positioning the gasket such that the gasket is spaced apart from the first bearing.

10. The method of claim **1**, wherein:

mounting the rotor on the shaft further includes sliding a first end of the base onto the shaft and into contact with the first bearing; and

positioning the second bearing and the coaxial support on the shaft further includes sliding the second bearing into contact with a second end of the base.

11. A method for installing a direct drive motor on a washing machine, comprising:

positioning a drum within a polymeric tub of a washing machine,

inserting a shaft secured to the drum at a first end into a first bearing, the first bearing being positioned in a first seat co-molded in the tub,

mounting a rotor on the shaft such that a base of the rotor contacts a notch formed in the shaft,

placing a second bearing in a second seat of a coaxial support, the coaxial support having a stator secured thereto,

mounting the second bearing and the coaxial support on a second end of the shaft positioned opposite the first end such that the second bearing contacts the base of the rotor, and

securing the coaxial support to the tub.

12. The method of claim **11**, wherein mounting the rotor includes sliding the rotor along the shaft until the base contacts the first bearing.

13. The method of claim **11**, further comprising:

securing the first bearing to a first length of shaft having a first shaft diameter, and

securing the rotor and the second bearing to a second length of shaft having a second diameter,

wherein the first shaft diameter is greater than the second shaft diameter.

14. The method of claim **11**, further comprising:

positioning an auxiliary bearing on the shaft, the stator extending radially away from the auxiliary bearing, and

inserting pin through the coaxial support and into the stator to prevent the movement of the stator.

15. The method of claim **11**, further comprising securing the stator to an inner surface of the coaxial support.

16. The method of claim **11**, further comprising forming a plurality of apertures in the rotor and forming a plurality of apertures in the coaxial support to permit the flow of cooling air.

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